EVIDENCE OF PRIMARY EVENTS IN 20Ne, 22Ne FRAGMENTATION FROM COINCIDENCE MEASUREMENTS IN 20, 22Ne + 93Nb REACTION AT 30 MeV/A

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Résumé - La compétition entre différents processus primaires de réaction est mise en évidence par l'étude des coïncidences particules légères-fragment du projectile dans les réactions induites par les projectiles ^{20}Ne et ^{22}Ne sur ^{93}Nb à 30 MeV/A. La structure du projectile joue un rôle important dans la compétition entre les mécanismes de pick-up, stripping et break-up.

Abstract - Evidence that primary ejectiles formation strongly depends on the projectile structure is given by comparison of ^{20}Ne + ^{93}Nb and ^{22}Ne + ^{93}Nb reactions at 30 MeV/A. Pick-up, stripping, break-up mechanism are identified using light particles-projectile fragments coïncidence measurements.

I - INTRODUCTION

Nuclear reaction involving excited states of the reaction fragments can generally be subdivised into the primary process and the subsequent deexcitation through light particles emission or fission. The mechanisms of transfer and break-up in ^{20}Ne induced reaction have been studied for the system ^{20}Ne + ^{197} Au [1] and ^{20}Ne + ^{27}Al [2] at bombarding energies up to 20 MeV/A respectively. Therefore in order to check the relative importance of different dissociation phenomena, we studied the two reactions ^{20}Ne + ^{93}Nb and ^{22}Ne + ^{93}Nb at 30 MeV/A.

II - EXPERIMENTAL

We performed on SARA coïncidence measurements between projectile like fragments and light particles. Mass identification and energy measurements of fragments are performed using two telescopes in the range 6 to 15 degrees. In fragment coïncidence measurements the fragment telescopes were set at 8.5°. The light particle (p,d,t,α) are detected in a 5 to 35 degrees angular range using either a telescope (300 µm Si detected + BaF_2 scintillator) or phoswich systems.

III - COINCIDENCE MEASUREMENTS ANALYSIS

When compared to ^{20}Ne results the mean feature to underline on ^{22}Ne fragmentation is the large amount of ^{15}N and ^{11}B isotope production and the observation of sodium isotopes. The coïncidences measurements on the two systems allow to understand most of

the observed features. The relative yield for proton and alpha coincidence with projectile like fragments is given on **figure 1.**

Let us first concentrate on ^{20}Ne induced reaction. The deexcitation of the ^{20}Ne* quasi projectile occurs preferentially through α emission by break-up mechanism or sequential decay. The signature of the two processes are given on **figure 2.** From their representation in the E_{HI}-E_{α} plane it can be recognized in **figure 2a** that for [^{16}O,α] events roughly one half of the strength is concentrated in a sharp peak which is, within the experimental resolution, consistent with zero energy transfer to the target nucleus. The other events are spread out over 50 MeV excitation energy range. In **figure 2b** the correlation geometry allows to select events corresponding of deexcitations of ^{20}Ne* through α emission. This deexcitation explains most of the ^{16}O and ^{12}C cross section observed. During the first step interaction between target and projectile a proton or [proton + neutron] transfer can occur. The so obtained ^{19}F or ^{18}F quasi projectile deexcite very easily by α emission such experimental decay leads to most of observed nitrogen and boron cross section. Similar analysis is performed concerning ^{22}Ne interaction. The deexcitation of ^{22}Ne* quasi projectile is not the dominant process. However ^{18}O,α coïncidence allows to put in evidence pure break-up mechanism. The competition with ^{21}Ne* and ^{20}Ne* primary events can be estimated from the ratio of coïncidence yields between ^{16}O-α/^{17}O-α/^{18}O-α or ^{12}C-α/^{13}C-α/^{14}C-α they are in the ratio 3/1.8/1. Furthermore the most interesting feature is the formation of ^{23}Na* through pick-up reaction (Q = +2.75 MeV). The signature for such process is given by the ^{19}F-α coincidence. The sequential decay of ^{23}Na* leads to extra amount of α-coincidence with fluor, nitrogen, boron isotopes. When looking at ^{15}N exclusive energy spectra deduced from α-^{15}N correlation, one can extract two components corresponding respectively to a mean value E_1 = 400 MeV which can be reproduced assuming an optimum Q value for pick-up process [3] and a constant fragment velocity during the following decay. The high energy component corresponds to a mean value E_2 = 440 MeV which can be calculated assuming an optimum Q value corresponding to stripping process (**figure 3**). Similar results are obtained from ^{11}B-α-coïncidence

The formation of ^{23}Na is also corroborated by fragments-fragments correlation which at (8.5-8.5) degree shows typical ^{11}B ^{12}C coïncidence. The energy distribution of both fragments is very narrow and the sum energy E(^{12}C) + E(^{11}B) = 630 MeV is very close to the incident one (**figure 4**). The missing energy corresponds to the Q value for fragmentation. However such interesting feature corresponds to a very small yield (less than 10%) compared to ^{11}B-α coïncidence.

IV - CONCLUSION

The comparison of the two entrance channel ^{20}Ne and ^{22}Ne allows to put in evidence that the primary events are strongly dependent upon the projectile structure. These first reaction steps are determinant in the isotope yields of projectile fragments even taking in account the sequential decay.

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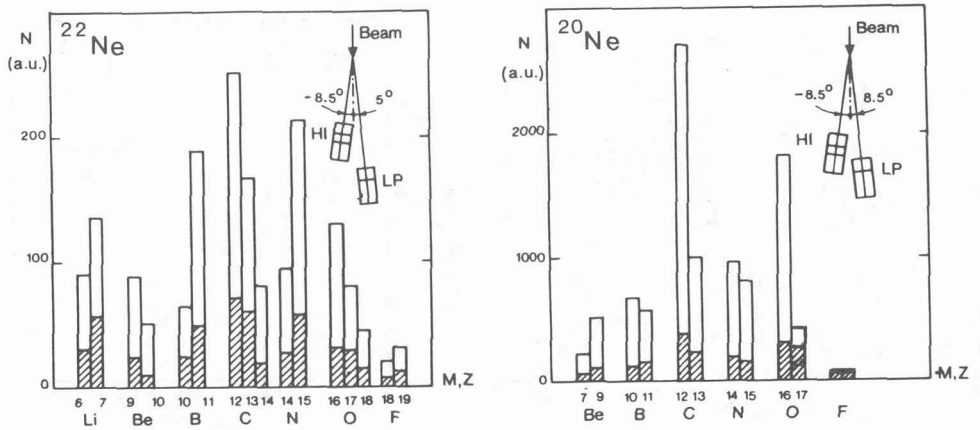

Figure 1 - *The relative yield of proton (dashed area) and alpha (total area) coincidence plotted as function of ejectile mass in ^{22}Ne and ^{20}Ne induced reaction.*

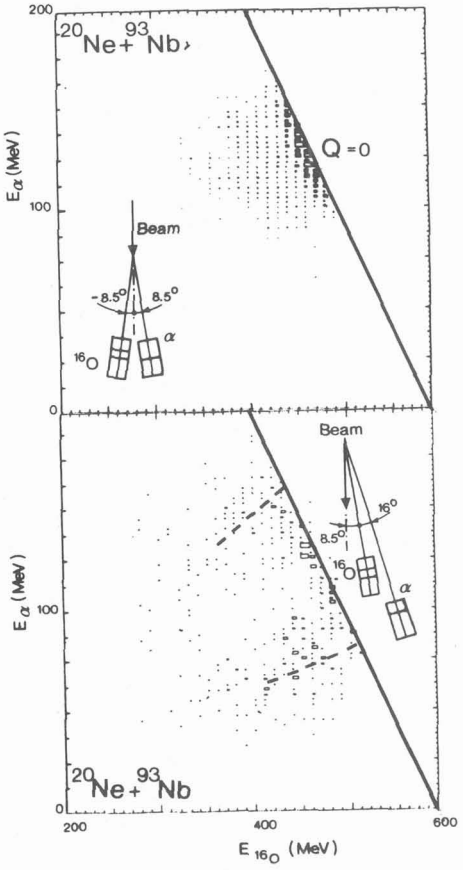

Figure 2 - *Distribution of events in the E_{HI}-E_{α} plane.*

*In **figure 2a** the solid lines mark the border consistent with zero energy transfer to the target (Q = 0).*

*In **figure 2b** the two dashed lines represent the mean value given by theoretical calculation for a statistical alpha emission from $^{20}Ne^{*}$.*

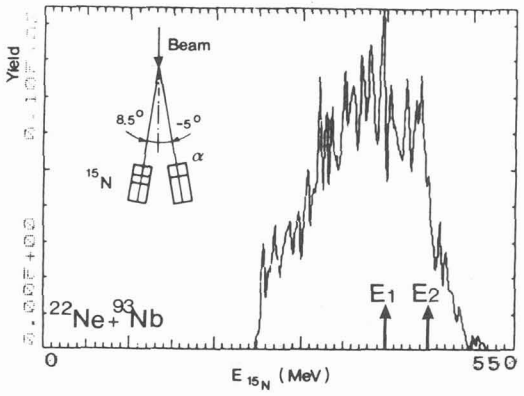

Figure 3 - *Energy spectra of the ^{15}N projectile like fragment in coincidence with α particles. E_1 and E_2 are the mean energy value of the two observed components.*

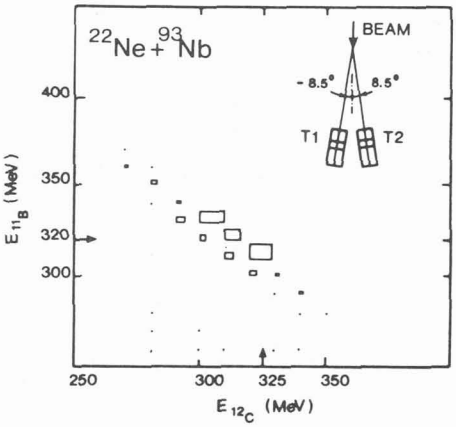

Figure 4 - *Distribution of events in E_{HI}-E_{HI} plane in case of ^{11}B, ^{12}C coincidence measurements in ^{22}Ne + ^{93}Nb reaction.*